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A Practical Method for Rapid Measurement of Skin Condition

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ABSTRACT

Maintaining skin integrity is important because of the skin's role in protecting the infant and providing innate immunity. Achievement of this goal requires constant vigilance and awareness of factors that can negatively impact the skin. The task can be particularly challenging for patients in the neonatal intensive care unit (NICU). Key to optimizing skin condition is methods to quantify the extend of skin compromise. Implementation of such methods allows caregivers to monitor effectiveness of treatments and practices to prevent skin damage. This paper briefly reviews skin breakdown in hospitalized patients and describes a validated, visually based method for rapid measurement of skin condition. Application of the method in the NICU setting is discussed.

Neonatal Skin Characteristics

Full term newborn infant skin is well-formed with excellent barrier properties, a thick epidermis, and full functionality at birth. The rate of transepidermal water loss (TEWL) from the epidermis is very low, 4–8 g/m^2/h at birth,[1,2] equal to or lower than adults, and indicating a highly effective skin barrier.[3,4]

Premature skin has a markedly thinner epidermis and a poorly formed stratum corneum (SC), i.e., a wounded skin surface, versus full term skin.[5,6] The dermis is deficient in structural proteins, the mechanical properties are poor, the skin is not resilient to mechanical stress and is easily torn.[7] The SC develops rapidly, however, one month later TEWL continues to be higher than normal.[8] Skin hydration is much higher in infants less than 30 weeks GA than older infants but decreases markedly by day 5 indicating rapid barrier formation.[9] Low humidity following birth increases epidermal DNA synthesis and triggers cell proliferation.[10] Levels of water binding FFAs are likely to be very low with rapid SC development.[11,12] For very premature infants, skin pH is higher for longer than older infants.[13] The higher pH may negatively impact normal SC functioning.[14] Estimates of complete premature SC maturation vary from 2–9 weeks postnatal age.[8,15–17] The poor skin barrier puts the infant at risk for increased permeability, high water loss, electrolyte imbalance, thermal instability, infection, skin compromise and delayed barrier maturation.[18] Interventions that facilitate SC development are essential for reducing the negative consequences of an immature barrier.[18,19]

Skin and the Neonatal Intensive Care Patient

Infants in the neonatal intensive unit (NICU) are at risk for skin compromise due to immature skin, compromised perfusion, fluid retention, immunocompromised, medical diagnosis, etc., as well as the presence of dressings, tapes, adhesives and various medical devices that are essential to their care. Internal processes, e.g., heart rate, respiration, temperature, are monitored continuously using devices attached to the skin surface. Fig. 1 shows an infant with several leads, a nasogastric tube, an endotracheal tube and a diaper. There are large lifting scales indicating skin dryness, most likely a consequence of premature birth and rapid skin barrier development. As a result and unfortunately, skin compromise can occur. Common examples are (1) erythema and inflammation from irritant dermatitis or diaper dermatitis, (2) dryness/scaling, (3) tape stripping, i.e., removal of the upper layer (s) of skin when tapes and dressings are detached, (4) occlusion induced irritation, (5) allergic contact dermatitis, (6) skin infection and (7) pressure ulcers. Figure 2 shows examples of skin compromise in NICU patients, including irritant dermatitis from secretions at a G-tube site, dryness/scaling, compromise from tape removal, and irritation from occlusion.

Measures of "Skin Condition"

Skin condition is described by the attributes erythema, dryness/scaling and rash. *Erythema* (abnormal redness from capillary dilation and increased blood flow) is the visible indicator of inflammation, infection or irritation.[20] Inherent skin pigmentation (i.e., brown, yellow, red colors due to melanin) influences the interpretation of visual erythema. Changes in blood, e.g., pooling in the tissues, affects the appearance of skin pigmentation.[21] Visual skin *dryness* is observed as scaling where the outermost layers are clumped together because they did not desquamate as single cells. Under normal visual conditions the lifting scales first appear as powderiness along the normal dermatoglyphic pattern of the skin surface. As the scales become larger, a cracking pattern appears between regions, indicating greater severity. Rash refers to discrete areas of irritation, called papules, often around a hair follicle and originating in the epidermis. When filled with fluid, the discrete areas are pustules and may be infected.

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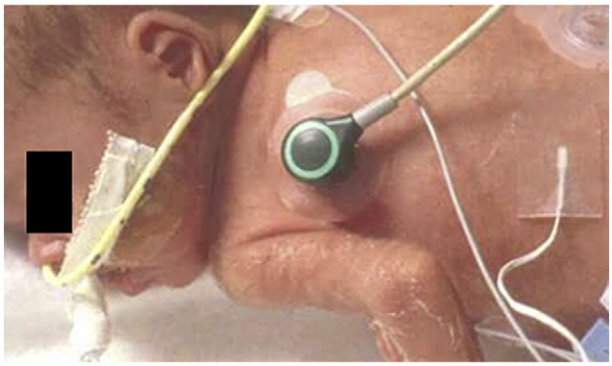

Fig. 1. NICU Patient with items "attached" to the skin. The infant has a nasogastric tube and an endotracheal tube taped to the skin of the face. There are several monitor leads attached to the back. Areas of dry, lifting scales are visible.

Skin Evaluation: General Principles

Skin evaluation methods describe the severity of erythema, dryness or rash relative to normal, healthy skin on the same person. The region of interest varies depending upon the situation. For example, if the interest is the skin condition following dressing removal, the region of interest would be the area covered by the dressing. For diapered infants, skin areas covered by the diaper are the buttocks, genital region, perineal region and intertriginous areas and they are judged separately and given separate scores. For NICU patients, the perineal region is likely to have more compromise than other regions.[22] The degree of skin compromise involves the area of involvement (within the region of interest) and severity of the compromise. The numerical scores derive from severity of damage, e.g., inflammation and erythema, and area (percent) of involvement with nearby areas of "normal", uninvolved skin as a reference.[22–25] Erythema is scored with a 9-point 0–4 scale with 0.5 grade increments and rash with a 7-point 0–3 scale with half grade increments. Dryness is measured on an 11-point 0–5 scale with 0.5 grade increments.[26]

Procedures and Tools

The method described here has been standardized, validated and used for studies globally. Health care workers have repeatedly demonstrated consistent, reliable results and find the method easy to use.[22,27] The step-by-step procedure, sample forms and grading keys are provided and described.

Step 1: Area of Interest

For a given patient, notice the basic skin coloration as there is high variability in patient to patient. This is important because red and yellow tones vary naturally with pigmentation and age, especially for premature infants as the stratum corneum develops. So, judgments are made relative to normal skin for that individual patient. Next, visualize the area of interest. Fig. 3 shows two examples, one for an area on the chest and the other for the perineal region. This will vary in size from patient to patient. The amount of area of skin damage is relative to the entire area.

Step 2: Mark Area on Template

Select a grading template. Fig. 4A shows one for erythema. Notice on the template the area choices are: none, <2%, 2%–10%, 10%–50% and >50%. These sizes are shown in Fig. 3. For the perineal area of a full term newborn, 2% is about the size of a pencil eraser or the tip of your small finger, 10% is about the size of your thumb print, 50% is half the area. Some find it easier to think this way: Is it <50%? If so, is it more than 10% or less than 2%. Mark the box on the template.

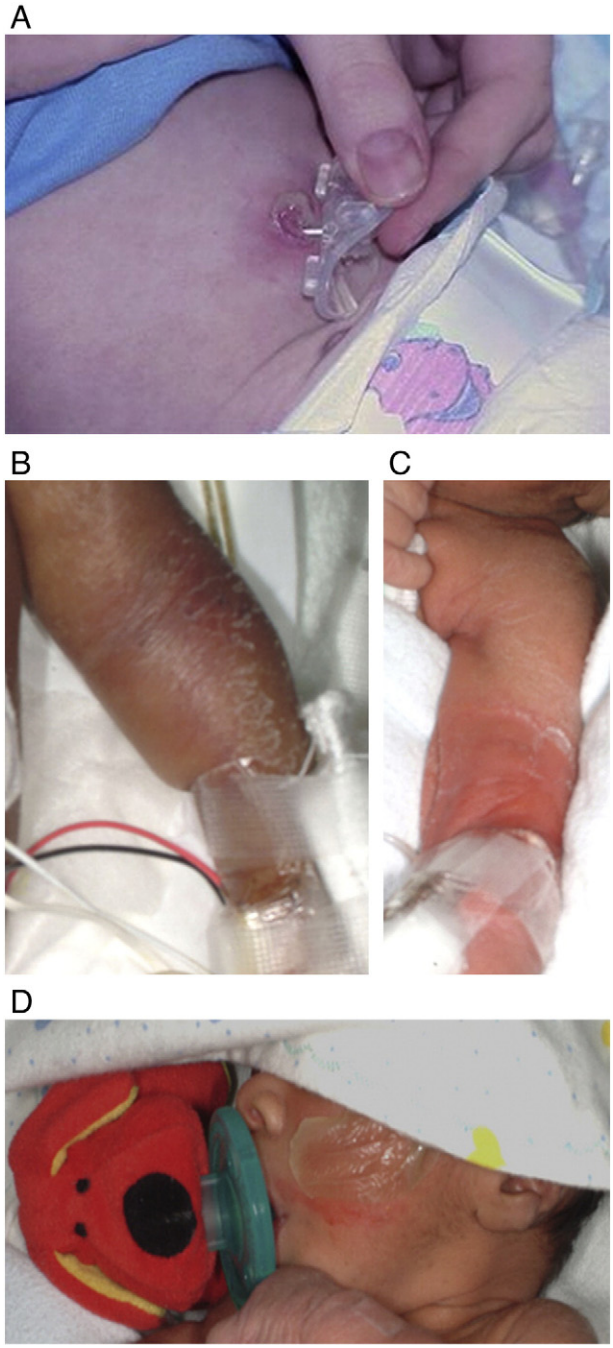

Fig. 2. Skin Compromise. Examples of skin compromise observed in NICU patients are shown here. Frame A shows irritant dermatitis under a G-tube due to secretions and moisture under the cover and, potentially, as a result of friction. Frame B shows dryness/scaling that can be a result of rapid skin barrier formation, in the case of a premature infant, or from prior inflammation. Frame C shows erythema above the PICC line caused by removal of the dressing. In tape stripping, some of the outer layers of skin are removed creating a superficial wound. As a result, the skin is more permeable to irritants and susceptible to infection. Frame D illustrates skin irritation caused by occlusion of normal skin from the film used to protect the skin from the tape used to secure the nasogastric tube. Occlusion causes transient water to build up under the film allowing the skin to become overhydrated. Too much hydration causes disruption of the stratum corneum lipids and subsequent inflammation.

Step 3: Mark Severity on Template

The final step is to determine the severity. Each template has gradations of severity. For erythema there are 4, for dryness 5 and rash only 2.